CANDIDATE AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: Cryptobranchus alleganiensis bishopi

COMMON NAME: Ozark Hellbender

LEAD REGION: 4

INFORMATION CURRENT AS OF: February 11, 2002

STATUS/ACTION (Check all that apply):
___ New candidate
_X_ Continuing candidate
    _X_ Non-petitioned
    ___ Petitioned - Date petition received: ___
        __ 90-day positive - FR date: ___
        __ 12-month warranted but precluded - FR date: ___
_____ Is the petition requesting a reclassification of a listed species?
    ___ Listing priority change
        Former LP: ___
        New LP: ___
___ Candidate removal: Former LP: ___ (Check only one reason)
    ___ A - Taxon more abundant or widespread than previously believed or not subject to a degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
    ___ F - Range is no longer a U.S. territory.
    ___ M - Taxon mistakenly included in past notice of review.
    ___ N - Taxon may not meet the Act's definition of "species."
    ___ X - Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Salamanders - Cryptobranchidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Arkansas, Missouri

CURRENT STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Arkansas, Missouri

LEAD REGION CONTACT (Name, phone number): Lee Andrews, 404/679-7217

LEAD FIELD OFFICE CONTACT (Office, name, phone number): Conway, Arkansas Field Office, Susan Rogers, 501/513-4481

BIOLOGICAL INFORMATION (Describe habitat, historic vs. current range, historic vs. current population estimates (# populations, #individuals/population), etc.):

Taxonomy

The Ozark hellbender (Cryptobranchus alleganiensis bishopi) was originally designated as C. bishopi by Grobman (1943) from a specimen collected from the Current River in Carter County, Missouri. Due to the small amount of genetic variation possessed by the genus Cryptobranchus (Merkle et al. 1977, Shaffer and Breden 1989), Schmidt (1953) referred to the Ozark hellbender as a subspecies of the eastern hellbender, C. alleganiensis, and this was supported by Dundee and Dundee (1965). This designation persisted until Collins (1991) revived C. bishopi, due to the lack of intergradation between the eastern and Ozark hellbenders, which is unlikely to occur due to the allopatry of populations of these species (Dundee 1971). Although Ozark hellbenders have been shown to be distinct phenotypically (Grobman 1943, Dundee and Dundee 1965, Dundee 1971) and genetically (Routman 1993, Wagner et al. 1999) from eastern hellbenders, the U.S. Fish and Wildlife Service will continue the use of C. a. bishopi, which is the name currently recognized by the Center for North American Amphibians and Reptiles (Collins 1997). Although discussion continues over the taxonomic status of the Ozark hellbender, the designation of the Ozark hellbender as a species or subspecies does not affect its qualification for listing under the Endangered Species Act (87 Stat. 884, as amended: 16 U.S.C. 1531 et seq.).

Description

The Ozark hellbender is a large, strictly aquatic salamander endemic to streams of the Ozark plateau in southern Missouri and northern Arkansas. Its dorso-ventrally flattened body form helps it remain immobile in the fast flowing streams it inhabits (Wagner et al. 1999). Hellbenders have a large, keeled tail and tiny eyes. Adult Ozark hellbenders may attain total lengths of 29 - 57 cm (Dundee and Dundee 1965, Johnson 1987). Numerous fleshy folds along the sides of the body provide surface area for respiration (Nickerson and Mays 1973a) and obscure poorly developed costal grooves (Dundee 1971). Ozark hellbenders are distinguishable from eastern hellbenders by their smaller body size, dorsal blotches, increased skin mottling, heavily pigmented lower lips, smooth surfaced lateral line system, and reduced spiracular openings (Grobman 1943, Dundee 1971, Peterson et al. 1983, LaClaire 1993).

Ecology and Habitat

Eastern and Ozark hellbenders are very similar in habitat selection, movement, and reproductive biology (Nickerson and Mays 1973a). Published works on the eastern hellbender may provide insights into Ozark hellbender ecology. Adult Ozark hellbenders are frequently found beneath large rocks in moderately deep (< 1m), rocky, fast-flowing streams in the Ozark plateau (Johnson 1987, Fobes and Wilkinson 1995, Wagner et al. 1999). In spring-fed streams, Ozark hellbenders typically concentrate just downstream of the area where there is no water temperature change throughout the year (Dundee and Dundee 1965). Adults are nocturnal, remaining beneath cover during the day and emerging to forage primarily on crayfish at night, although they are not entirely nocturnal (Nickerson and Mays 1973a, Noeske and Nickerson 1979, Collins 1997). Ozark hellbenders are territorial and will defend occupied cover from conspecifics (Nickerson and Mays 1973a). This species migrates little, with one tagging study revealing that 70 percent

of marked individuals moved less than 30 meters from the site of original capture (Nickerson and Mays 1973b). Home ranges average 28 square meters for females and 81 square meters for males (Peterson and Wilkinson 1996).

Typically, Ozark hellbender populations are dominated by older, large adults (Nickerson and Mays 1973a, Peterson et al. 1983, LaClaire 1993). Juveniles reach sexual maturity between 5 and 8 years, with males maturing at a smaller size and younger age than females. Ozark hellbenders may live 25 - 30 years in the wild (Peterson et al. 1983).

Breeding generally occurs between September and November, with Spring River, Arkansas populations breeding in January (Peterson et al. 1983). Ozark hellbenders mate via external fertilization, and males will guard the fertilized eggs from predation by conspecifics (Nickerson and Mays 1973a). Clutch sizes vary from 138 to 450 eggs per nest (Dundee and Dundee 1965, Zug 1993), and eggs hatch after approximately 80 days (Zug 1993). Hatchlings and larvae are collected rarely during surveys, likely due to low capture efficiency and high mortality of young. Larvae and small individuals often live beneath small stones in gravel beds or shallow water habitats (Nickerson and Mays 1973a, LaClaire 1993).

Distribution

Ozark hellbenders are endemic to the Black and White River drainages in Arkansas and Missouri (Johnson 1987) in portions of the Spring, White, Eleven Point, and Current Rivers and their tributaries (LaClaire 1993). This species is believed to be declining throughout its range, and no populations appear to be stable. Declines have been evident throughout the range of the eastern hellbender, as well, which holds state protective status in many eastern states. Because the two subspecies are very similar, closer scrutiny has revealed a similar, more recent decline in Ozark hellbenders. A description of what is known about Ozark hellbender populations follows.

White River System

White River- There is only one Ozark hellbender record from the main stem of the White River, coming from Baxter County, Arkansas, in 1997 (Dr. S. Trauth, ASU, pers. com.). It is not known whether a viable population exists at this site or if the individual captured is a member of a relic population that was separated from the North Fork White River population by Norfork reservoir. Much of the hellbender habitat was destroyed by the series of dams constructed in the 1940's and 1950s on the upper White River, including Beaver, Table Rock, Bull Shoals, and Norfork dams. A status survey for the Ozark hellbender was scheduled for the lower portion of the White River during summer 2001, but the results of this survey have not been finalized.

North Fork White River- The North Fork White River historically contained a considerable Ozark hellbender population. In 1973, results of a mark-recapture study indicated approximately 1,150 hellbenders within a 2.67 km reach of river in Ozark County, Missouri, with a density of one individual per eight to ten m^2 (1/8-10 m^2) (Nickerson and Mays 1973b). Ten years later, hellbender density in a 4.6 km section of the North Fork White River in the same county remained rather high, with densities between one per six to seven m^2 and one per 13 to 16 m^2 (Peterson et al. 1983). Individuals caught in this study also represented a range of lengths (172 -

551 mm), indicating that reproduction was occurring in this population, and most individuals were sized at between 250 - 449 mm. Subsequently, in a 1992 qualitative study in Ozark County, Missouri, 122 hellbenders were caught during 49 man-hours of searching (Ziehmer and Johnson 1992). These individuals ranged from 254 - 457 mm, and no average size was included in this publication.

Up to the 1992 study, the North Fork White River population appeared to be fairly healthy. However, in a 1998 study of the same reach of river censussed in 1983 (Peterson et al. 1983) and using the same collection methods, only 50 hellbenders were captured (Wheeler et al. 1999). These individuals ranged in length from 200 - 507 mm, with most being between 400 - 500 mm, and were on average significantly longer than those collected twenty years earlier (Wheeler 1999). This shift in length distribution was not a result of an increase in maximum length of individuals; instead, there were fewer individuals collected in the smaller size classes.

In order to compare results between these qualitative and quantitative studies, Wheeler et al. (1999) converted historical hellbender collections (Peterson et al. 1983) to numbers of individuals caught per day. In addition, the other studies that were not included in that conversion (Peterson 1983, Peterson 1988, Ziehmer and Johnson 1992) have been converted here. For comparison purposes, one search day is defined as 8 hours of searching by 3 people (i.e., 24 person-hours). Although this search day may be an underestimate of actual effort, a conservative estimate of effort will result in a conservative estimate of hellbender population declines. Therefore, in 1983, approximately 51 hellbenders were caught per sampling day (Peterson et al. 1983). In 1992, 60 hellbenders/day were caught (Ziehmer and Johnson 1992), and, in 1998, 16 hellbenders/day were caught (Wheeler 1999). Based on these comparisons, a decline in the North Fork White River is evident.

The North Fork White River had been considered the stronghold of the species, and the populations inhabiting this river were deemed stable (Ziehmer and Johnson 1992, LaClaire 1993). However, these populations now appear to be experiencing declines similar to those in other streams. The collection of young individuals has become rare, indicating little recruitment. In species such as the Ozark hellbender, which are long lived and mature at a relatively late age, detecting declines related to recruitment can take many years, as recruitment under healthy population conditions is typically low (Nickerson and Mays 1973a). A gradual, long-term decline appears to be occurring in the North Fork White River, although quantitative studies are needed to determine the likely effects of this decline on the population.

Bryant Creek- Bryant Creek is a tributary of the North Fork White River in Ozark County, Missouri, which flows into Norfork Reservoir. Ziehmer and Johnson (1992) expected to find Ozark hellbenders in this stream during an initial survey, but none were captured or observed after 22 man-hours. This apparent lack of the species conflicted with reports from Missouri Department of Conservation (MDC) personnel and fisherman who reported observations of fairly high numbers of hellbenders in Bryant Creek during winter months (Ziehmer and Johnson 1992). A subsequent survey of the creek resulted in the capture of 6 hellbenders (Wheeler et al. 1999), confirming the existence of a population in this tributary. However, this population is isolated

from the other North Fork White River populations by Norfork reservoir, which could contribute to this population's apparent small size.

Black River System

Black River- There are no documented records of Ozark hellbenders in the Black River, although it has not been extensively surveyed. Portions of the Black River in Missouri were surveyed in 1999 by researchers at Arkansas State University, but no Ozark hellbenders were observed (Wheeler et al. 1999). The Black River is presumed to be part of the historic range of the species, due to the presence of hellbenders in several of its tributaries, including the Spring, Current, and Eleven Point Rivers (Firschein 1951, Trauth et al. 1992).

Spring River- The Spring River, a tributary of the Black River, flows from Oregon County, Missouri, south into Arkansas. Ozark hellbender populations have been found in the Spring River near Mammoth Spring, Fulton County, Arkansas (LaClaire 1993). In the early 1980's, 370 individuals were captured during a mark-recapture study along 7 km of stream south of Mammoth Spring (Peterson et al. 1988). Hellbender density at each of the two surveyed sites was fairly high (approximately one per 23 m^2 and one per 111 m^2). These individuals were considerably larger than hellbenders captured from other streams during the same time period, with 74 percent of Spring River Ozark hellbenders measuring over 450 mm total length (maximum 600 mm) (Peterson et al. 1988). This may indicate that Spring River populations are somewhat distinct genetically from other Ozark hellbender populations. This conclusion was upheld by a genetic study of the Spring, Current, and Eleven Point River populations (Wagner et al. 1999). In 1991, a longer reach (26 km) was surveyed for Ozark hellbenders, and only 20 were observed during 41 search hours over a 6 month period, at many of the same sites sampled by Peterson et al. (1983) (Trauth et al. 1992). No length information is available, although the large sizes of the 1988 captures may be indicative of a population experiencing little recruitment. Although the recent surveys were less intensive than the previous studies, it is apparent that hellbenders have declined in this stream.

Eleven Point River- The Eleven Point River, a tributary of the Black River, has been surveyed several times since the 1970's. Historical data provided by Peterson was analyzed by Wheeler (1999). In 1978, 87 hellbenders were captured in Oregon County, Missouri, over 3 days, yielding 29 hellbenders/day. Later, in 9 collection days from 1980 - 1982 in the same area, 314 hellbenders were captured, yielding 35 hellbenders/day. Lengths over this period ranged from 119 - 451 mm. Six years later, Peterson et al. (1988) captured 211 hellbenders from the Eleven Point River and estimated hellbender density to be approximately one per 20 m^2. Total lengths of these individuals ranged from 120 - 450 mm, with most between 250 - 350 mm. Although it was not presented, it can be estimated that roughly 40 hellbenders were caught per day during this study. Approximately 10 years later, Wheeler (1999) captured 36 hellbenders over 4 days from Peterson et al.'s (1988), for an average of 9 hellbenders/day. These hellbenders were larger than those captured previously, with total lengths of 324 - 457 mm, and there were significantly fewer individuals in the smaller size classes. In summary, the population appeared stable until 1988 (captures of 29, 35, and roughly 40 hellbenders/day), and then dropped in 10 years to 9 hellbenders/day, and these individuals were considerably larger than those caught previously.

Therefore, in the Eleven Point River, similar declines and lack of recruitment are evident as in other streams.

Current River- The Current River had not been surveyed extensively until the 1990's. Nickerson and Mays (1973a) reported a large population in this stream, but no numbers were presented. In 1992, Ziehmer and Johnson (1992) found 12 Ozark hellbenders in 60 man-hours in Shannon County, Missouri, or approximately 5 hellbenders/day, using the same search day conversion as presented above. These individuals ranged in length from 115 mm to over 380 mm (maximum length was not reported), with most between 330 mm and 380 mm. Seven years later, 14 hellbenders were collected over 3 collection days (approximately 5 hellbenders/day), also in Shannon County, Missouri, and the individuals ranged from 375 - 515 mm, with most between 450 - 499 mm (Wheeler 1999). It appears that this population is small, and may not be declining. However, the average size of individual has increased by nearly 100 mm, and this population shows a lack of recruitment.

Jacks Fork- Jacks Fork, a tributary of the Current River, was surveyed for the first time in 1992 for Ozark hellbenders (Ziehmer and Johnson 1992). Four hellbenders were collected over 66 man-hours, roughly 2 hellbenders/day. The individuals were large, ranging from 330 - 430 mm. There have been no subsequent investigations of Jacks Fork, so no conclusions may be drawn about population trends in this stream.

THREATS (Describe threats in terms of the five factors in section 4 of the ESA providing specific, substantive information. **If this is a removal of a species from candidate status or a change in listing priority, explain reasons for change**.):

A. The present or threatened destruction, modification, or curtailment of its habitat or range. The decline of the Ozark hellbender in the White and Black River systems in Missouri and Arkansas is likely the result of habitat degradation, in the form of impoundments, ore and gravel mining, silt and nutrient runoff, and den site disturbance due to recreational uses of the rivers it inhabits (Williams et al. 1981, LaClaire 1993). Although the precise causes of hellbender declines are likely complex interrelationships among threats and the species' life history characteristics, habitat degradation is the most frequent cause of lotic faunal declines (Allan and Flecker 1993). Hellbenders are habitat specialists that depend on constant levels of dissolved oxygen, temperature, and flow (Williams et al. 1981). Therefore, even minor alterations to stream habitat are likely detrimental to hellbender populations.

   Impoundments impact stream habitat in many ways. When a dam is built on a free-flowing stream, riffle and run habitats in the area impounded by the dam are converted to open water. As a result, water temperatures tend to increase and dissolved oxygen levels tend to decrease, due to the lotic conditions of the water (Allen 1995). Because hellbenders are habitat specialists, they cannot tolerate a wide range of habitat conditions. Hellbenders depend upon highly vascularized lateral skin folds for respiration; therefore, lakes and reservoirs are unsuitable habitats for Ozark hellbenders, as these areas have

lower oxygen levels and higher water temperatures (Williams et al. 1981, LaClaire 1993) than do fast flowing, cool water, highly oxygenated stream habitats. In addition, impoundments on inhabited streams create unsuitable habitat for hellbenders and, therefore, are impediments to movement between populations. In the upper White River, construction of Beaver, Table Rock, Bull Shoals, and Norfork dams in the 1940's and 1950's has destroyed much of the historic hellbender habitat that occurred there and has effectively isolated hellbender populations.

Norfork dam was constructed on the North Fork White River in 1944 and has isolated Ozark hellbender populations in Bryant Creek and the White River from those in the North Fork White River. Additionally, populations downstream of Beaver, Table Rock, Bull Shoals, and Norfork dams were extirpated due to hypolimnetic releases from the reservoir. These releases are much cooler than normal stream temperatures, and the water in such releases is typically depleted of oxygen. In addition, the tailwater zones below dams experience extreme water level fluctuations and scouring for many miles downstream which impact hellbender populations by washing out the gravel and chert used by juveniles and creating unpredictable habitat conditions that fluctuate outside the Ozark hellbender's range of tolerance.

Gravel mining has occurred in many southeastern streams, including a number of streams within the historic range of the Ozark hellbender, which has contributed to Ozark hellbender habitat alteration and loss. Dredging results in stream instability both up and downstream of the dredged portion (Neves et al. 1997, Box and Mossa 1999). Head cutting, in which the increase in transport capacity of a dredged stream causes severe erosion and degradation upstream, results in extensive bank erosion, sloughing, and increased turbidity levels (Allan 1995). Reaches downstream of the dredged stream reach often experience aggradation as the sediment transport capacity of the stream is reduced (Box and Mossa 1999). These activities disturb hellbender den sites in dredged areas, and associated silt plumes can cover downstream den sites. In addition, these effects reduce crayfish populations, which are the primary prey species for Ozark hellbenders. Gravel dredging is widespread in the White and Black River systems in southern Missouri and northern Arkansas (LaClaire 1993). Modifications of stream channels associated with gravel mining, as well as the removal of small stones and chert that are important microhabitat for larvae and subadults, contribute to the decline of Ozark hellbenders in these systems.

Portions of the Ozark plateau have a history of being major producers of lead and zinc, and some mining activity still occurs in the southeastern Ozarks, though at less than historic levels. Results of a recent USGS water quality study in the Ozark plateau revealed that concentrations of lead and zinc in bed sediment and fish tissue were substantially higher at sites with historical or active mining activity and that these concentrations were high enough to suggest adverse biological effects, such as reduced enzyme activity or death of aquatic organisms. Although mining for lead and zinc no

longer occurs within the range of the Ozark hellbender, elevated concentrations are still present in the streams where mining occurred historically (Petersen et al. 1998).

Despite the claim by some that many Ozark streams outwardly appear to exist in pristine conditions, Harvey (1980) clearly demonstrated that various sources of pollution exist in the ground water in the Springfield-Salem Plateaus of southern Missouri. In comparing ground-water quality of sites within the Ozark Plateaus (including Arkansas and Missouri) with other National Water-Quality Assessment Program (NAWQA) sites, Petersen et al. (1998) documented that: 1) nitrate concentrations in parts of the Springfield Plateau aquifer were higher than in most other NAWQA drinking-water aquifers, and 2) volatile organic compounds were detected more frequently in drinking-water aquifers within the Ozark Plateaus than in most other drinking-water aquifers. These studies overlap well with the current distribution of Ozark hellbender in Arkansas and Missouri.

Silt and sediment runoff from land use activities in the area have contributed to habitat degradation. Hellbenders are intolerant of siltation and turbidity (Nickerson and Mays 1973a) and can be impacted by these in several ways. First, sediment deposition in den sites will cover and suffocate eggs. Second sediment will fill in interstitial spaces in gravel/chert areas, reducing suitable habitat for larvae and subadults (FISRWG 1998). Third, suspended sediment loads can also cause water temperatures to increase, as there are more particles to absorb heat, thereby reducing dissolved oxygen levels (Allen 1995). Because the Ozark hellbender requires cool temperatures and high levels of dissolved oxygen, perturbations to environmental conditions can be detrimental to hellbender populations. Fourth, the Ozark hellbender's highly permeable skin causes them to be negatively affected by sedimentation. Various chemicals, such as pesticides, bind to silt particles and become suspended in the water column when flushed into a stream. The hellbender's permeable skin provides little barrier to these chemicals, which can be toxic (Blaustein and Wake 1990, Wheeler et al. 1999).

Timber harvesting is prominent in many areas within the range of the Ozark hellbender, and roads probably introduce the bulk of suspended sediment through erosion from road construction and the sediment-transporting ability of constructed roads. Roads can also cause marginally stable slopes to fail, and they capture surface runoff and channel it directly into streams (Allan 1995). In addition, erosion from roads contributes more sediment than the land harvested for timber (Box and Mossa 1999). Peak stream flows often rise in watersheds with timber harvesting activities, due in part to compacted soils resulting from roads, landings, and vegetation removal (Allan 1995, Box and Mossa 1999). The cumulative effects of timber harvest on sedimentation rates last for many years, even after harvest practices have ceased in the area (Frissell 1997).

Nitrogen and phosphorus are essential plant nutrients that are found naturally in streams. However, elevated concentrations of these nutrients causes excessive growth of aquatic algae and plants in many streams and has detrimental effects upon water quality.

Contamination of water in the Ozark plateau by nutrients has occurred from runoff of poultry and cattle wastes, human wastes, and fertilizers. National Water Quality Assessment (NAWQA) data collected in the Ozarks in 1993-1995 from wells and springs indicated that nitrate concentrations were strongly associated with the percentage of agricultural land near the wells or springs. In addition, fecal coliform levels have been elevated in these areas (Petersen et al. 1998). Livestock wading in streams, poor agricultural practices that lead to the degradation of riparian buffer zones, and faulty septic and sewage treatment systems have resulted in these elevated levels, which cause more algae to grow on streambed rocks. This growth affects aquatic species composition and causes benthic-feeding organisms to thrive (Petersen et al. 1998). Agriculture comprises approximately 30 percent of the land use within the range of the Ozark hellbender, which is intolerant of nutrient pollution (Nickerson and Mays 1973a).

Habitat disturbances may also be affecting hellbender success in several rivers. Canoeing and fishing are common in many of the rivers inhabited by the Ozark hellbender, including the Spring, Current, and North Fork White Rivers. Although no data are available that support this assertion, it has been speculated that the disturbance of den sites by contact with canoes may lead to the abandonment of those sites. In addition, some larger rocks have been removed in order to prevent canoe damage (Nickerson and Mays 1973a, Wheeler et al. 1999). The areas under these large rocks are used as hellbender den sites, so, if these rocks are removed, the number of available den sites is diminished.

B. Overutilization for commercial, recreational, scientific, or educational purposes. Anecdotal reports indicate that Ozark hellbenders have been collected for commercial and scientific purposes (Trauth et al. 1992). Commercial collections are currently illegal in both Missouri and Arkansas, but in Arkansas, hellbenders may be collected with a permit from the Arkansas Game and Fish Commission. Missouri imposed a moratorium on hellbender collecting from 1991 to 1996 and has since only allowed limited numbers of collecting permits (P. Horner, Missouri Department of Conservation, pers. com.). Nonetheless, illegal collecting for the pet trade has been documented, with one report of over 100 hellbenders illegally collected nearly 18 years ago (P. Horner, Missouri Department of Conservation, pers. com.), and likely remains a threat. In addition, there are unpublished reports of hellbenders killed accidently killed by frog giggers, who may gig a hellbender inadvertently.

When considered cumulatively, collection and illegal or unintentional harvest is a threat to many of the declining hellbender populations. Because the species is long lived and does not reproduce until approximately age 7, the removal of even a few individuals from a population that is experiencing declines can impact the recruitment potential of that population. Presently, collecting levels appear reduced (LaClaire 1993), but collecting could become more of a threat if populations continue to decline.

C. Disease or predation. The occurrence of disease is virtually unknown in Ozark hellbender populations and has been studied little. Although young hellbenders are occasionally preyed upon by large fish, turtles, and water snakes, this is rare due to their noxious skin secretions and likely does not occur after hellbenders reach 380 mm (Nickerson and Mays 1973a, Peterson et al. 1983). It is unlikely an otherwise healthy population would be threatened by natural levels of predation. No evidence has been presented that would indicate that disease or predation are serious threats.

D. The inadequacy of existing regulatory mechanisms. The states of Arkansas and Missouri prohibit the taking of Ozark hellbenders for any purpose without a state scientific collecting permit. However, enforcement of this permit requirement is difficult. Additionally, state regulations do not protect hellbenders from other threats. Existing authorities available to protect riverine ecosystems, such as the Clean Water Act (CWA), administered by the Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers, may not have been fully exercised in an effort to prevent in-stream activities and the resulting habitat degradation. This may have contributed to the general habitat degradation apparent in riverine ecosystems and decline of both eastern and Ozark hellbender populations throughout their ranges. Although the Ozark hellbender coexists with other federally listed species throughout parts of its range, listing under the Endangered Species Act would provide additional protection, as the threats to hellbenders and the other endangered species are not identical.

Currently, there are no regulations governing best management practices (BMPs) of timber harvesting, which would reduce impacts on water quality. Existing BMPs are established by the Arkansas Forestry Commission and Missouri Department of Conservation and lack mandatory requirements for implementing methods to reduce aquatic resource impacts associated with timber harvests. Many timber harvests involve clear-cutting to the streambank, which promotes bank erosion.

E. Other natural or manmade factors affecting its continued existence. Certain population characteristics of Ozark hellbenders cause the species to be fairly vulnerable to extirpations and extinction. The Ozark hellbender, having specialized habitat requirements, is extremely vulnerable to environmental perturbations. When populations are small, they are less likely to rebound following these perturbations. In addition, Ozark hellbenders exhibit very low genetic diversity (Merkle et al. 1977, Wagner et al. 1999). This genetic uniformity is consistent with habitat specialization (Nevo 1978, Wagner et al. 1999). Ozark hellbenders have adapted to a relatively constant environment, and, therefore, several structural, behavioral, and physiological specializations have resulted (Williams et al. 1981). These specializations, in combination with the stable environment, seems to have resulted in very low levels of genetic diversity (Wagner et al. 1999). Fragmentation of populations by impoundments, habitat degradation, and other impediments to dispersal may exacerbate this situation. Without the level of interchange the hellbender experienced historically, many small, isolated populations do not receive the influx of new genetic material that once occurred.

As the populations decrease in size, genetic diversity is lost and inbreeding can occur, which may result in decreased fitness, and the loss of genetic heterozygosity can result in a significantly increased risk of extinction in localized natural populations (Saccheri et al. 1998). This is illustrated by Routman's (1983) study, in which hellbender populations from different rivers showed very little within-population variability, and relatively high between-population variability. Due to this population fragmentation, local extinctions cannot be repopulated.

Ozark hellbenders do not reproduce until approximately 7 years of age. Declines being observed presently may be the result of activities that occurred years earlier. Because juvenile hellbenders are rarely observed, it takes many years to detect population trends. The lack of recruitment in most Ozark hellbender populations is a significant sign that little reproduction has occurred in these populations for several years. Delayed reproduction, when paired with a long life span, can disguise declines until they become fairly severe.

The present distribution and status of Ozark hellbender populations in the White and Black River systems in Arkansas and Missouri may be demonstrating the characteristics mentioned above. Genetic studies have repeatedly demonstrated very low genetic diversity in hellbender populations, which may be a factor in the decline of the species. The current combination of population fragmentation and habitat degradation may prohibit this species from recovering without the intervention of conservation measures designed to facilitate hellbender recovery.

BRIEF SUMMARY OF REASONS FOR REMOVAL OR LISTING PRIORITY CHANGE:

FOR RECYCLED PETITIONS:

a. Is listing still warranted? ___
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? ___
c. Is a proposal to list the species as threatened or endangered in preparation? ___
d. If the answer to c. above is no, provide an explanation of why the action is still precluded.

LAND OWNERSHIP (Estimate proportion Federal/state/local government/private, identify non-private owners): Approximately 80 percent of the land within the range of the Ozark hellbender is in private ownership, with the remaining 20 percent federally owned and managed by the U.S. Forest Service (Mark Twain National Forest).

PRELISTING (Describe status of conservation agreements or other conservation activities): No conservation agreements have been developed for the Ozark hellbender. However, the states of Arkansas and Missouri have identified the need for conservation of this species. Although the species is not state listed, Missouri has provided extra protection for the Ozark hellbender in the Wildlife Code of Missouri, outlawing collection of hellbenders. Outreach has been considerable

in both states, which have erected signs throughout the range of the Ozark hellbender alerting recreationists to their presence. Additionally, numerous stream surveys have been conducted by both states. The Missouri Department of Conservation is potentially planning to include Ozark hellbenders in their five-year threatened and endangered species plan, with tributary surveys and life history studies included. Presently, the Service, U.S. Geological Survey, and Arkansas Game and Fish Commission have funded surveys to fill in unsurveyed gaps in the distribution of the species in Arkansas and Missouri, and work is being done at Mammoth Springs National Fish Hatchery to examine potential refugia as well as life history characteristics.

REFERENCES (Identify primary sources of information (e.g., status reports, petitions, journal publications, unpublished data from species experts) using formal citation format):

Allan, J. D. 1995. Stream ecology: structure and function of running waters. Chapman and Hall, New York, NY.

Allan, J. D. and A. S. Flecker. 1993. Biodiversity conservation in running waters. Bioscience 43:32-43.

Box, J. B. and J. Mossa. 1999. Sediment, land use, and freshwater mussels: prospects and problems. Journal of the North American Benthological Society 18:99-117.

Blaustein, A. R. and D. B. Wake. 1990. Declining amphibian populations: a global phenomenon? Trends in Ecology and Evolution 5:203-204.

Collins, J. T. 1991. Viewpoint: a new taxonomic arrangement for some North American amphibians and reptiles. Herpetological Review 22:42-43.

Collins, J. T. 1997. Standard Common and Current Scientific Names for North American Amphibians and Reptiles: Fourth Edition Updated, Society for the Study of Amphibians and Reptiles, Herpetological Circular 25:1-40.

Dundee, H. A. 1971. Cryptobranchus, and C. alleganiensis. Catalogue of American amphibians and reptiles: 101.1-101.4.

Dundee, H. A. and D. S. Dundee. 1965. Observations on the systematics and ecology of Cryptobranchus from the Ozark plateaus of Missouri and Arkansas. Copeia 1965:369-370.

Federal Interagency Stream Restoration Working Group. 1998. Stream corridor restoration: principles processes, and practices. www.usda.gov/stream_restoration

Firschein, I. L. 1951. The range of Cryptobranchus bishopi and remarks on the distribution of the genus Cryptobranchus. The American Midland Naturalist 45:455-459.

Fobes, T. M. and R. F. Wilkinson. 1995. Summer, diurnal habitat analysis of the Ozark hellbender, Cryptobranchus alleganiensis bishopi, in Missouri. Final Report, Southwest Missouri State University.

Frissell, C. A. 1997. Ecological Principles. Pp 96-115 In: J. E. Williams, C. A. Wood, and M. P. Dombeck, eds. Watershed restoration: principles and practices. American Fisheries Society, Bethesda, MD.

Grobman, A. B. 1943. Notes on salamanders with the description of a new species of Cryptobranchus. Occasional papers of the Museum of Zoology, University of Michigan Press, Ann Arbor, MI.

Harvey, E.J. 1980. Ground water in the Springfield-Salem Plateaus of southern Missouri and northern Arkansas. U.S. Geological Survey, Water Resources Investigations 80-101. 66pp.

Johnson, T. R. 1987. The amphibians and reptiles of Missouri. Missouri Department of Conservation, Jefferson City.

LaClaire, L. V. 1993. Status review of Ozark hellbender (Cryptobranchus bishopi). U.S. Fish and Wildlife Service status review. Jackson, Mississippi.

Merkle, D. A., S. I. Guttman, and M. A. Nickerson. 1977. Genetic uniformity throughout the range of the hellbender, Cryptobranchus alleganiensis. Copeia 1977:549-553.

Neves, R. J., A. E. Bogan, J. D. Williams, S. A. Ahlstedt, and P. W. Hartfield. 1997. Status of aquatic mollusks in the southeastern United States: a downward spiral of diversity. Pp. 43-85 *in* G. W. Benz and D. E. Collins, eds. Aquatic fauna in peril: the southeastern perspective. Southeast Aquatic Research Institute, Decatur, GA.

Nevo, E. 1978. Genetic variation in natural populations: patterns and theory. Theoretical Population Biology 13:121-177.

Nickerson, M. A. and C. E. Mays. 1973a. The hellbenders: North American "giant salamanders." Milwaukee Public Museum Publications in Biology and Geology 1:1-106.

Nickerson, M. A. and C. E. Mays. 1973b. A study of the Ozark hellbender Cryptobranchus alleganiensis bishopi. Ecology 54:1164-1165.

Noeske, T. A. and M. A. Nickerson. 1979. Diel activity rhythms in the hellbender, Cryptobranchus alleganiensis (Caudata: Cryptobranchidae). Copeia 1979:92-95.

Petersen, J.C., Adamski, J.C., Bell, R. W., Davis, J.V., Femmer, S.R., Freiwald, D.A., and Joseph, R.L. 1998. Water quality in the Ozark plateaus: Arkansas, Kansas, Missouri, and

Oklahoma. U.S. Geological Survey Circular 1158, on line at URL: http://water.usgs.gov/pubs/circ1158, updated April 3, 1998

Peterson, C. L., D. E. Metter, and B. T. Miller. 1988. Demography of the hellbender Cryptobranchus alleganiensis in the Ozarks. American Midland Naturalist 119:291-303.

Peterson, C. L. and R. F. Wilkinson, Jr. 1996. Home range size of the hellbender (Cryptobranchus alleganiensis) in Missouri. Herpetological Review 27:127.

Peterson, C. L., R. F. Wilkinson, Jr., M. S. Topping, and D. E. Metter. 1983. Age and growth of the Ozark hellbender (Cryptobranchus alleganiensis bishopi). Copeia 1983:225-231.

Routman, E. 1993. Mitochondrial DNA variation in Cryptobranchus alleganiensis, a salamander with extremely low allozyme diversity. Copeia 1993:407-416.

Saccheri, I. M. Kuussaari, M. Kankare, P. Vikman, W. Fortelius, and I. Hanski. 1998. Inbreeding and extinction in a butterfly metapopulation. Nature 392:491-492.

Schmidt, K. P. 1953. A checklist of North American amphibians and reptiles. 6th edition. American Society of Ichthyologists and Herpetologists.

Shaffer, H. B. and F. Breden. 1989. The relationship between allozyme variation and life history: non-transforming salamanders are less variable. Copeia 1989:1016-1023.

Trauth, S. E., J. D. Wilhide, and P. Daniel. 1992. Status of the Ozark hellbender, Cryptobranchus bishopi, (Urodela: Cryptobranchidae), in the Spring River, Fulton County, Arkansas. Proceedings of the Arkansas Academy of Science 46:83-86.

Wagner, B. K., H. Kucuktas, and R. Shopen. 1999. Hellbender genetics project final report: evaluation of the genetic status of the Ozark hellbender population in the Spring River, Arkansas. Arkansas Game and Fish Commission, Little Rock, AR.

Wheeler, B. A. 1999. Status of the Ozark hellbender (Cryptobranchus alleganiensis bishopi): a long-term assessment. M.S. Thesis. Southwest Missouri State University, Springfield, MO.

Wheeler, B. A., E. Prosen, A. Mathis, and R. Wilkinson. 1999. Missouri hellbender status survey: final report. Missouri Department of Conservation, Springfield, MO.

Williams, R. D., J. E. Gates, C. H. Hocutt, and G. J. Taylor. 1981. The hellbender: a non-game species in need of management. Wildlife Society Bulletin 9:94-100.

Ziehmer, B. and T. Johnson. 1992. Status of the Ozark hellbender in Missouri. Missouri Department of Conservation, Jefferson City, MO.

Zug, G. R. 1993. Herpetology: an introductory biology of amphibians and reptiles. Academic Press, San Diego, CA.

LISTING PRIORITY (place * after number)

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6*
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes to the candidate list, including listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all additions of species to the candidate list, removal of candidates, and listing priority changes.

Approve: /s/ Judy Pulliam 4/4/02
Acting Regional Director, Fish and Wildlife Service Date

Concur: _____ _____
Director, Fish and Wildlife Service Date

Do not concur: _____ _____
Director, Fish and Wildlife Service Date

Director's Remarks: _____

_____

_____

Date of annual review: February 11, 2002

Conducted by: Susan Rogers - Conway, Arkansas FO

Changes from October 30, 2001 CNOR? (check one)Yes___ No_X__

Approve: _____ _____
Regional Director, Fish and Wildlife Service Date

Comments: _____

_____

_____

_____

(rev. 6/00)